2022

HYDROLOGY AND WATER RESOURCE ENGINEERING

Full Marks – 100

Time – Three hours

The figures in the margin indicate full marks
for the questions.

Answer question No.1 and any *four* from the rest.

1. Write short notes by providing sketches wherever
   applicable on any *five* from below :   5×4=20

   (a) Elements of hydrologic cycle relevant to
   water resource engineering.

   (b) Optimal number of rain gauge stations in a
   catchment.

   (c) A crest staff gauge for estimating peak
   discharge.

   (d) A Flow Duration Curve.

   (e) Basic assumptions and the limitations of the
   Unit Hydrograph theory.

   [Turn over

(f) Rational formula for estimating flood flow from a catchment together with the expression for computing the intensity of rainfall for use in this formula.

(g) Phreatic surface and piezometric surface in case of aquifers.

(h) Flood routing.

2. (a) Either answer questions (i) to (iii) Or (iv) and (v) :   4+2+2=8

   (i) How would you define normal rainfall at Kokrajhar according to the currently applicable guidelines of the India Meteorological Department (IMD) ?

   (ii) What is a Water-year

   (iii) How are months of a water-year categorized into different seasons according to IMD ?

Or

   (iv) What is the source of western disturbance and when does it occur ?

   (v) How is a tropical cyclone formed and what are its characteristics ?   4+4=8

(b) An annual rainfall of 112 cm over a catchment of area of 150 km² produced outflows from the catchment at average rates of 2 m³/s for 3 months, 3 m³/s for 6 months and 5 m³/s for the remaining period in the year. Show that

(i) the runoff coefficient of the catchment, and

(ii) the change in the amount of abstraction from rainfall for a change of the runoff coefficient to 0.5 would be 0.61, 18.5 Mcum (Million Cubic Metre) respectively.

3+3=6

(c) (i) What are the advantages of a Self-Recording Rainfall Gauge (SRRG) over an Ordinary Rain Gauge (ORG)?

(ii) Which among SRRG and ORG readily produces a mass curve of rainfall.

4+2=6

3. (a) (i) Categorize different methods of measuring discharge of a river into direct and indirect methods.

(ii) Describe the area velocity method of measuring discharge at a section in a river by providing a suitable sketch and relevant formulae.

4. (a) (i) Define a Unit Hydrograph (UH). Draw the typical shape of a D-hour UH.

   (ii) What do the commonly used acronyms ERH and DRH stand for and how would you define these ?

   (iii) If a 6-hour UH simplified to the shape of a triangle for a catchment has a base width of 120 hour and a peak of 10 Cumec, then show that the area of that catchment would be 216 km².

   $4+4+2=10$

   (b) What are the two methods for deriving a UH of a duration different from that of a given UH ? Which of these is more versatile ? Describe any one method with a sketch.
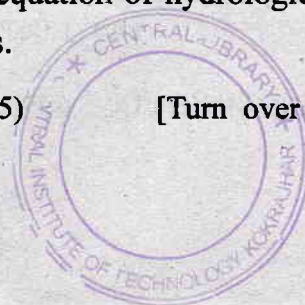
   $2+2+6=10$

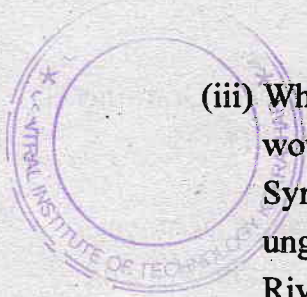5. (a) (i) Write the Dicken's empirical formula for estimating peak discharge specifying the units of measurement.

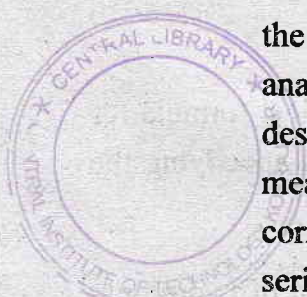   (ii) Write the general equation of hydrologic frequency analysis.

(iii) What Physical Catchment Descriptors would you require for deriving a Synthetic Unit Hydrograph of an ungauged catchment on the Gaurang River by the method recommended by the Central Water Commission in India ?

$3+3+4=10$

(b) (i) Define Return Period of a flood flow.

(ii) The design discharge of a hydraulic structure on a river is 350 m³/s. If a record of 20 years of annual maximum flood at the location of the hydraulic structure is available, and if the mean and standard deviation of that annual flood series are estimated as being 121 and 60 m³/s respectively, then show by applying the Gumbels' method of flood frequency analysis that the return period of the design flood is 100 years. The reduced mean and reduced standard deviation corresponding to the sample size of the series considered may be taken as 0.5236 and 1.0628 respectively. $2+8=10$

98/19/6thSem/UCE 605 (6)

6. (a) (i) Describe with a suitable sketch the meaning of an unconfined aquifer, an artesian aquifer and a leaky aquifer.

(ii) What is the type of aquifer that is linked to the volume of water contained in the ponds in your Institute.

(iii) Write an expression of the Darcy's law for estimating ground water flow by describing the terms used with appropriate units of measurement. 6+2+4=12

(b) (i) Derive an expression for estimating steady flow into a well fully penetrating an unconfined aquifer.

(ii) Calculate the hydraulic conductivity and transmissibility of a 10 m thick confined aquifer having a 10 cm diameter well fully penetrating the aquifer if the steady state drawdowns at distances of 10 m and 40 m from the centre of the well were 2.5 m and 0.05 m respectively when the well was pumped at a constant rate of 125 litre/min. 4+4=8

98/19/6thSem/UCE 605 (7) [Turn over
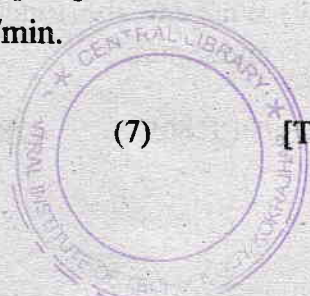
7. (a) The following is the Google Earth imagery of the Gaurang River on the south-west of your Institute. Which amongst the Braided, Deltaic and Meandering categories would describe the morphology of this river stretch ? What are the crescent shaped water bodies seen in the imagery called ? 2+2=4
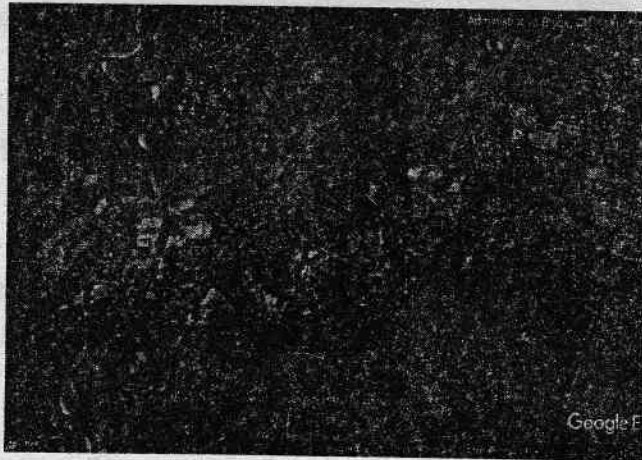
(b) Answer the following questions : 4×4=16

(i) Why is training in a river necessary ?

(ii) How are river training works classified ?

(iii) What are different types of river training works ?

(iv) What are the functions of Guide bunds and Spurs ?

98/19/6thSem/UCE 605   (8)   100
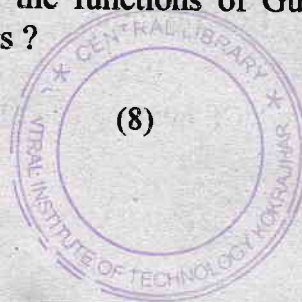
8. (a) Describe the various flood control measures for reducing

   (i) the peak flow and

   (ii) the peak stage for mitigating damage from flood. 6+6=12

   (b) What are the likely impacts of climate change on occurrence of flood ? What are likely causes of urban flooding in India. 4+4=8